THE BLOOD OF THE EARTH

By G. H. SCHWABE

Dr. Schwabe, whom our readers will remember from the December 1942 issue, has a passion for doing what his earlier article was called—"Tracing Life's Secrets." In his unceasing search for new answers to the riddles of Nature, this brilliant young scientist has found a most promising field of research in hot springs—the blood that boils in the veins of our Mother Earth. He has studied hot springs in Iceland, Germany, Chile, and Japan. In the following pages he presents some of the amazing discoveries made in this field and their implications. —K.M.

AN icy November wind swept across the lonely wastes of Iceland. Like powdered glass, the whirling snow dust cut into our faces. Our oilskins creaked and crackled at every step, stiff with cold. The three of us chewed dried fish and tramped for hours through the white desert without speaking. The winter days are short, high up in the North, with hardly a few hours of daylight around noon. When the wind slackened for an instant, we saw in front of us, on a gentle slope, a small white cloud taking shape—our goal.

At last we were there and stood in growing amazement before a little world of miracles. After a few moments we lay in the snow in order the better to be able to observe these miracles under the cloud of steam. In the midst of the wintry desolation of the tundra—treeless, white, and cold—a thin trickle of hot water bubbled up out of the ground, melted a hole in the white monotony, and disappeared once more, bubbling and plashing, under the snow.

This dark hole in the wintry desert, no more than two or three steps wide, no more than a tiny piece of wet, stony ground—this is the whole world of miracles. Small though it is, it has its own laws, against which even the almost all-powerful winter of Iceland is powerless. The snowflakes melt before they reach the ground; at the edges, the snow dissolves into a glassy mass and builds a wall around steaming carpets of algae, poison green in color and bordered with red. Tiny flies, adorned with myriads of minute pearls of steam, leap back and forth over it in low jumps. A few spiders greedily lie in wait around the swarm. All about there is death and wintry sleep, while here the eternal struggle for existence goes on without respite. Moving slowly and as if armor-plated against their whole environment, snails graze on the meadow of algae, in whose thick pile white maggots, the coming generation of the frail thermic flies, are fattening.

How priceless a gift of Mother Earth is this tiny sphere of life! A little constantly flowing warm water has opened a breach for life in the fortress of winter. May the sun temporarily prefer the other hemisphere of our planet: here growth, conception, birth, life, struggle, and death still go on. Heat and water, the elements of life, are there, inexhaustible and eternal.

But wait: heat, water, and—light! Without the light of the sun, no green plant, not even an alga, and hence no animal, can exist. Only those streaming, glistening tufts of sulphur bacteria in the hottest water, down there where it surges up from the ground, only those can do entirely without sun. They actually endure when the light-hungry meadow of algae gradually shrinks and, streaming and glistening, they even last through the long winter night, lit only by the trembling aurora borealis, while all other life must patiently wait in eggs, cocoons,

seeds, and spores for the return of the sun.

Even the tiny world of miracles in the cold, white monotony contains the secrets of the greatest of riddles, that of life.

When we—an Icelandic sailor and two German students—got up out of the snow with limbs stiff from cold and faces wet with steam, Nature herself had given us a lesson and, as she always does, sent us off with a bagful of questions.

PREHISTORIC LIFE

Once upon a time, in the early days of our planet, all waters and particularly all springs were probably warm or hot. Gradually the planet's thin outer skin lost its heat to the icy universe, and hot streams became rare. Now and again, for periods of a few thousand years or more, glacial periods laid their glassy armor over wide regions and seas. Smoking craters and steaming springs probably broke even through this armor and made dark holes in the shining white wastes. Hot springs created islands of life in the kingdom of white death.

Hot and warm streams, whether they flowed or still flow in polar deserts or in tropical jungles, are among the oldest workshops of life. Perhaps it was from here that life began its triumphal march at least over our planet. Ancient forms and prehistoric destinies have their home in hot springs, whether they once bubbled through the grass forests of the Carbon Age or now have their source somewhere between the shores of the oceans and the peaks of the Himalayas. But from all, even the youngest, groups of the flora and fauna up to Man himself, creatures born in later aeons have had a forming and reshaping influence on these centers of prehistoric life.

REVOLT AGAINST THE SUN

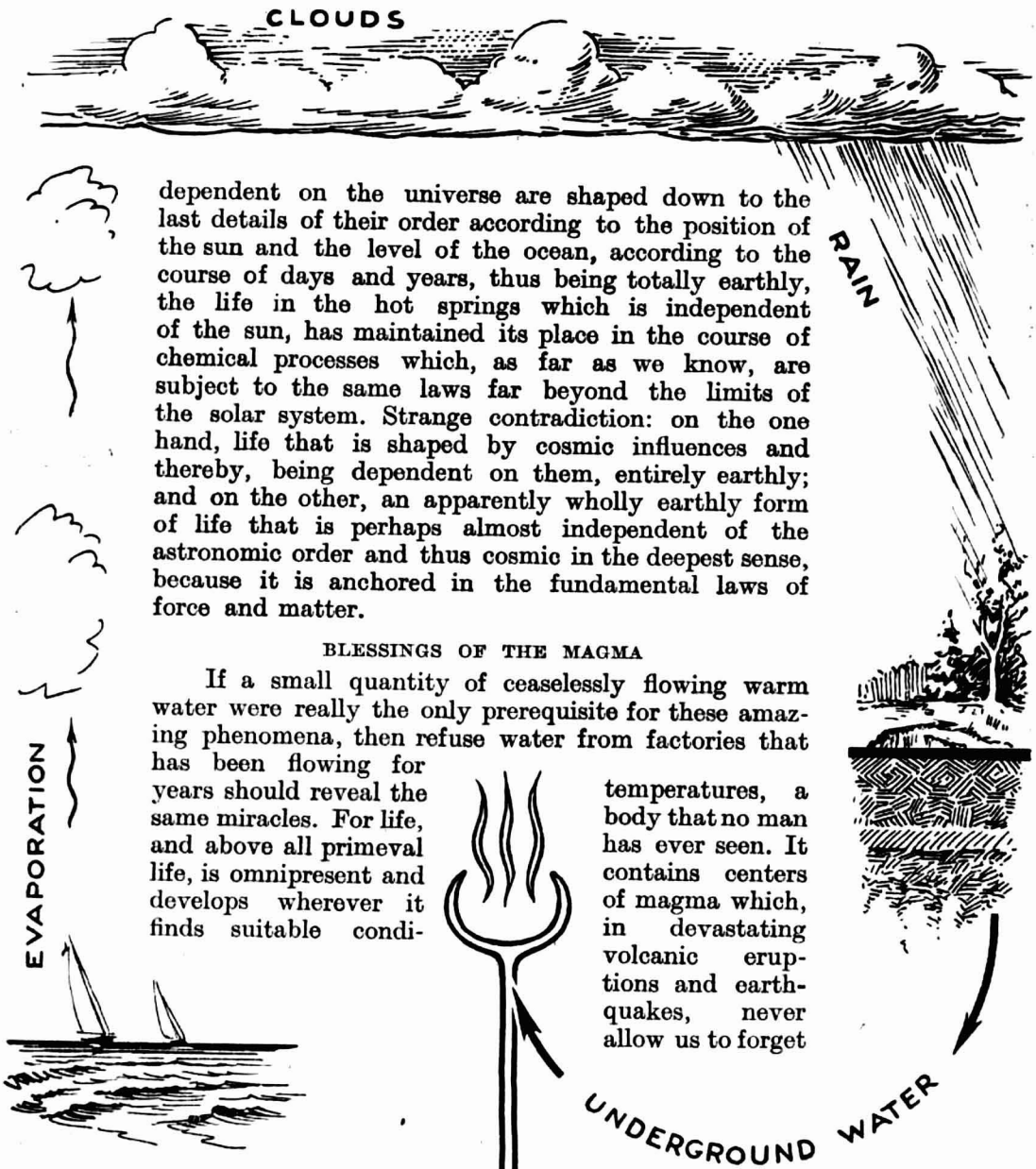
Without the sun there is no life! Only with the aid of sunlight can a green plant form its building materials—albumen, fats, sugar, starch, cellulose, and a host of other bodies—from the earth's disintegrating crust. And creatures with red blood can only live because green plants live.

Without the sun there is no life? No! At the spots where hot water bubbles up, there is another life that knows how to do without sunlight. The advance guards of all living things, the sulphur bacteria and their distant relations, obtain their force of life, not directly or indirectly from the sun, but from chemical conditions and processes peculiar to thermal water. Perhaps these advance guards of life on this planet will also be its rear guards, which will one day destroy all organic matter again; but life itself is probably stronger than our aging planet.

However, the main forces of life are still under the sign of the sun. The sun still determines the great climatic belts of the earth from pole to pole, it still creates storms and weather, moves rivers and ocean currents, and drives the eternal pendulum of the seasons. Life subjects itself to this planetary order, set up and maintained by the sun. This order separates tropical jungles from subpolar tundras, and mountain meadows from wandering dunes. In accordance with it, the burgeoning spring follows upon withered leaves, and brisk morning upon the sleep of night.

Only Man and the creatures in the hot water try to revolt against this order of the sun; the former by attack, only too often struck with blindness, blindness toward the sun which ends in his own ruin; the latter, however, in obedience to their own, more ancient laws and in defense of their inherited place in creation. So hot springs create islands of tropical life at the edge of eternal ice, summer growth in winter, and unceasing daytime activity deep in the night.

The loud, variegated life covering the face of the earth is dependent on the course of the sun and thus on happenings in the universe far removed from the earth. But that other, entirely earthly and ancient life has its home deep in the hot blood of Mother Earth. Amazing contradictions become apparent here. While the so-called higher forms of life



dependent on the universe are shaped down to the last details of their order according to the position of the sun and the level of the ocean, according to the course of days and years, thus being totally earthly, the life in the hot springs which is independent of the sun, has maintained its place in the course of chemical processes which, as far as we know, are subject to the same laws far beyond the limits of the solar system. Strange contradiction: on the one hand, life that is shaped by cosmic influences and thereby, being dependent on them, entirely earthly; and on the other, an apparently wholly earthly form of life that is perhaps almost independent of the astronomic order and thus cosmic in the deepest sense, because it is anchored in the fundamental laws of force and matter.

BLESSINGS OF THE MAGMA

If a small quantity of ceaselessly flowing warm water were really the only prerequisite for these amazing phenomena, then refuse water from factories that has been flowing for years should reveal the same miracles. For life, and above all primeval life, is omnipresent and develops wherever it finds suitable conditions. However, upon closer observation we find, even in chemical and physical respects, a difference between natural warm streams and those artificial ones, a difference that can be compared to that between a living creature and its corpse.

Under the precarious, thin crust of hard rock which encompasses our planet there is an inner body in a state of extreme tension and temperatures, a body that no man has ever seen. It contains centers of magma which, in devastating volcanic eruptions and earthquakes, never allow us to forget their existence. But, on the other hand, it is to them, too, that the surface of the earth owes its hot springs and a large part of its cold mineral springs. In places where the outer skin of our planet is weaker and where its rock is more deeply fissured, magmatic gases, which are very hot and at a very high tension, find their way out. These gases either form smoking craters and fumaroles (*solfataras*)

or penetrate into underground water which they heat and in which they dissolve to a large extent. Through the pressure and heat caused thereby, they drive this water to the surface of the earth, where it appears as a hot spring. In cases where the loss of heat on its underground passage is considerable, the water may come to the surface as a cold mineral spring.

All other springs exclusively produce water that originates from the circle: evaporation—atmospheric vapor—clouds —rain—surface water. The elements, too, that are dissolved in such water originate in life circles of the earth's surface or in the mineral strata through which the water has passed. In contrast to this, the hot springs and mineral springs mentioned above also transport water and elements originating in the magma to the surface, thus introducing them for the first time into the life circles there.

We call such springs, whether hot or cold, "foreign to their environment" (*"umraumfremd"*) or, for lack of a better term, "nonenvironmental," because their nature is, in many respects, sharply distinguished from that of other springs of their environment. Thus, in the final analysis, their character is determined by elements and forces of magmatic origin. As the result of numerous observations, we have come to the conclusion that the gases of the magma contain the vapors of almost all or all the elements. Above all, the magma, when cooling off, produces water too. Hence "juvenile" water—that is to say, water originating from magma and not from the earth's surface—and "omnipresence of the elements" are named as characteristics of water foreign to its environment. In it, the most rare of the elements can be found, at least in traces, radium being one of the best known of these.

CURIOUS CHEMICAL CHANGES

But even this chemical wealth, which is enhanced by the presence of isotopes (so to speak, extremely rare twin brothers of the various elements), is still not the most important characteristic of the hot or mineral spring under discussion. Its water, laden with elements from the earth's center, issues from great depths and high temperatures, in other words, from conditions under which the chemical and physical laws known to us surface creatures are more or less modified. Under the pressure of many atmospheres, a much greater number of gases dissolves in water, which is liquid at a temperature far above the boiling point up here on the surface. Under these conditions, harmless carbon dioxide turns into a corrosive substance, and the relationship between the elements shifts. Thus a hot corrosive liquid surges up through manifold mineral strata, gnawing and dissolving. While its pressure and temperature gradually sink, the water goes on dissolving new substances in the rocks it is passing through and releases other substances, especially gases, while it is in constant chemical reaction with the rocks and minerals.

Suddenly the water reaches the surface of the earth, while innumerable chemical processes are still taking place as the result of former reactions and, in addition, it may be mixing with cold underground water. This water, still laden as it is with all kinds of chemical and physical tensions, is now suddenly exposed to the effects of air and light. Now, for instance, hydrogen sulphide is reduced to sulphur and on to sulphurous acid or sulphuric acid; dissolved substances which are not light-proof disintegrate; and any number of chemical processes take place which, in addition, partially influence or cause each other.

EARTHQUAKES AND WATER

This, then, is what we call nonenvironmental water: a solution of almost all or all elements, many of which can have the effect of catalyzers, intrinsically containing unbalanced tensions, undergoing chemical changes, and in this condition exposed to the modifying effects of air and light.

Every slight earth tremor, registered only by sensitive instruments and whose

center lies far away, affects the delicate chemical nature of a nonenvironmental spring. A fine, imperceptible tremor of the ground causes changes in the salt concentration of its water. And yet even a nonenvironmental spring which seems so entirely earthly and has its roots in the very heart of our planet, is not free from cosmic bonds. The German scientist who was the first to see reflections of distant tremors in the salt concentration of his spring also discovered a further, far more remarkable relationship: every year in the autumn of our hemisphere, while the earth passes through a swarm of meteorites, and only then, the water of his spring shines with a greenish tinge under a Tyndall light, this tinge being caused by a slight cloudiness. Science is still faced by riddles here; all we are sure of so far is that there must be mysterious connections between happenings in the magma and in the universe.

THE LIBERATION OF MAN

Modern Man was proud only of the achievements of the world as he had created it, proud of progress. This world knows and makes use of substances, bodies, and forces, and continually discovers and invents new ones. But with its storehouses full of instruments and knowledge and its collections filled with useful goods and facts, it resembles more and more a vast museum of life which no longer houses any life. All recognizable phenomena of Nature were described and supplied with nameplates; all perceptible forces and substances were ordered and categorized. The system had definitely won. Those who served it were given their monuments.

There it stands, that gigantic museum, and gives an answer to every sensible question. It keeps on growing, and yet it is dead. For it contains only that which fits into systems, systems into which it is tacitly assumed that the cosmos will also fit. But suddenly systems and orders are threatened, suddenly modern Man is faced again by almost forgotten necessities. Starvation, danger, misery, and war are hostile to all systems. The giant museum is helpless; and in his agony Man must dive deep down into primeval times, when all orders were determined by necessity.

Who was the inventor of the sword, the plow, the stove, the wheel, and the sail, and how did he create these primordial tools, the basis of all engineering? Who discovered the power of the sun, the laws of heredity, the forces of the earth, of fire, and of water? Although these discoveries and inventions are more important than all subsequent ones, we do not know the names of their inventors; but we know that those times conversed with demons and spirits. And every true ordeal still forces Man to hold similar, almost forgotten colloquies.

This is why modern research must do more than trace and register the laws and phenomena of Nature, must do more than serve practical ends. It must establish contact with all those forces which hold the structure together and which direct the movements within that structure. In ancient times, these forces were the demons of the earth and of life, and apparently they still are today.

FRAGMENTS OF PRIMEVAL KNOWLEDGE

That which we are now gradually rediscovering and beginning to understand in the thermal springs is nothing but fragments of primeval knowledge translated into another language. As long ago as the dawn of history there were sacred springs, even in places where there was more than enough water. What is significant is that today these springs have been recognized as nonenvironmental and that they have also proved to be of healing power to medical science. "Fountain of youth," "*eau de jouvence*," "*Gesundbrunnen*," "*agua santa*," and "*agua de la vida*" are a few of the ancient, popular names which betray something of that knowledge of the demons.

Indian tales from the colonial times in south America tell about the discovery of a famous mineral spring by a sick dog, which bathed itself to health in its waters.

German peasant stories speak of a wounded stag which found such water and in this way taught humans its use. As long as there are no exact observations, these, like many other similar stories, remain just legends to us. Although the Icelandic hot springs are landmarks and resting places for bird migrations, the medicinal bath is probably unknown to animals and is a human discovery, although one of the oldest of all. There were periods when it was forgotten, but the memory always returned, as it has today.

In olden times, the healing bath had a much deeper and wider meaning. All over the world, demons and gods were once venerated at springs. Bathing and drinking the water were ritual, or at least actions influenced by religion. There was no sharp distinction between the ritual and the healing bath. Baptism, however, as an act of symbolic cleansing is probably of quite different origin and has scarcely any connection with the ancient ritual healing bath in springs. Essentially, however, the bath has always been something more than and something different from cleansing.

THE JAPANESE BATH

Bathing is an elemental experience of the senses, in which Man undergoes his most intimate contact with the elements as well as with the demons of water. The Japanese, who has always had a particularly close relationship to water, has probably maintained the character of this elemental experience more purely than anyone else. To do away at once with a frequent misconception: the Japanese bath has nothing to do with an urge for cleanliness. On the contrary, the Japanese cleanses himself thoroughly before bathing, and then, alone or in company, he gets into the water, which is either from a hot spring (温泉) or is kept hot in a high wooden tub with a built-in stove. The water is always hot, preferably between 107 and 117 degrees Fahrenheit, and deep enough for the head to be above the water when one is in a crouching position. The temperature should be just below or just on the border line of pain. Just as the Japanese squats when he is waiting or meditating, so he squats in his bath. The slightest movement causes currents of the hot water which touch upon the border line of bearable pain. As motionless as possible, enjoying to the full his intimate contact with water and heat, the bather develops an amazing endurance. It is at least probable that such a bathing custom did not arise solely from the contact with thermal waters but that it also does full justice to the nature of these springs, in that the bather, so to speak, devoutly gives himself up to the waters bubbling up from the depths, almost to the point of pain. Such an attitude reveals a true bathing cult.

Two other Japanese customs prove that the above are not arbitrary interpretations but palpable facts: the time bath and the waterfall bath. In the time bath (時間湯)—now only customary in Kusatsu and Nasu—which serves medical purposes, the experience of the water's heat is increased to the utmost. With the temperatures of the time bath —which reach more than 120 degrees— the limits of pain are overstepped, especially as the spring water, because of its high acid content, has an extremely caustic effect on the irritated or diseased skin. A strict ritual, which begins with choral singing and preparing of the bath to be taken by thirty or forty people together, and the time limit of three minutes set for the bathing, alleviate the individual bather's torture. In the waterfall bath, which is apparently also known in the Malayan regions and which is very popular, the experience of moving water is acutely developed. The naked body, especially the shoulders and the bent back, is placed under streams of water as thick as a man's thigh which fall from a height of several meters.

OF THE ELEMENTAL EXPERIENCE OF BATHING

In the rest of the world—if we disregard a few exceptions such as the Finnish *sauna*—the cult of bathing seems to have degenerated and become affected by other influences, so that bathing can

be said to have only athletic, medicinal, or cleansing significance. With such conceptions it is not possible to grasp the essence of the hot-spring or mineral bath. Perhaps the athletic attitude is closest to this essence. A science of healing springs, however, which attempts to explain all methods and customs of bathing therapeutically, is just as far off the path as a medical science which banishes into the realm of fable the still unexplained healing powers of nonenvironmental water.

The right path is not to be found in the middle but by regaining a genuine bathing experience. For modern Man, this elemental experience is only possible when far removed from all comfort, from the desire for cleanliness, and from all theories of bathing—but also far removed from cheap romanticism. Those who, after days of riding through the desert or after unbuckling their snowshoes, get into a steaming spring under the open sky in an uninhabited region may be granted this elemental experience.

THE HARNESSED SPRING

In our times, the hot or mineral spring is gradually regaining its importance as an irreplaceable, natural cure. This development is closely bound up with the simultaneous decline of a period of history in which the human being was regarded as a perfect machine, and in which it was believed that all other natural phenomena could be understood accordingly.

Today we know that many extremely rare substances of the water, some of which are very effective catalyzers, can penetrate the skin of the bather and enter his blood stream, and that the drinking of mineral-spring waters can have unparalleled effects on diseased organs. Research into the nature of healing baths has presented us with innumerable additional fragments of knowledge regarding the

nature and the effects upon human beings of nonenvironmental waters. Although the majority of these fragments are still unconnected, they justify the hope that medical science will continue to an everincreasing extent to make use of hot and mineral springs.

In more recent times, these springs have also been made use of for other purposes. Owing to lack of wood or other fuel, Icelandic farmers often heat their houses by a hot-water pipe laid under the floor from the farmyard spring. The possibility of using thermal water in this way has been the decisive factor in the settlement of many areas, and this still partly holds good today. From heating houses, it is only a step to the building of water-heated incubators for fowl. From heated vegetable beds near hot springs, the farmer has moved on to green- and hothouses with thermal heating. In 1930, on the occasion of the thousandth anniversary of the founding of the Icelandic Parliament, the builder of the first thermal hothouses—a German farmer—was able to present the King of Denmark and Iceland with the first grapes grown in Iceland.

Engineering does not stop at exploiting heat. To a growing extent a number of elements, some of which are extremely rare, are being obtained from hot-spring or mineral waters or their deposits, the sinters. Among the gases present in springs, carbon dioxide, methane, and precious gases play an important role in modern engineering. Part of the methane that is so widely used in Italy as a motor fuel, for instance, is probably obtained from springs. Helium, the incombustible substitute for hydrogen in airships, is in its origin foreign to its environment. Technical developments in connection with springs are in their very beginnings, and the future outlook is promising.

CHAOS AND CREATION

Countless thousands of hot and cold springs foreign to their environment spout forth from the outer skin of the earth, from the shores of the ocean as far up as under the ice of the loftiest mountains. As far as we know, only the ocean floors and the ice caps of the poles are free from waters of this kind. The regions most richly endowed with them are Iceland, Japan, Alaska, Yellowstone Park (USA), and New Zealand. In the two first-named countries, the hot springs play an important part in the history and life of the people. In the usually crystal-clear, cold air of Iceland, steaming springs (*reykir*) are landmarks in uninhabited regions. They have often become favorite spots for farm settlements and appear in innumerable place-names. The harsh climate has contributed to the fact that there is probably no other nation to which hot springs are of greater importance than the Icelanders. The mighty old Geysir in Haukadalur, which tosses up its mass of boiling water every day to a height of more than fifty meters, has become a symbol not only to the Icelanders: today all hot springs of that type are called "geysers."

It is hardly a coincidence that in Iceland, just as in Japan, the fumarole fields, which form a bridge between hot and mineral springs on the one hand and volcanic phenomena on the other, are given exactly the same name. The Icelandic word "*viti*" (*helviti*), like the Japanese "*zigoku*" (地獄), can only be translated by "hell" or "inferno." And in Yellowstone Park there is a fumarole field known as the "Devil's Cauldron." Indeed, it would be hard to find a better name for these infernal landscapes with their boiling mud puddles and hissing jets of steam, with their sulphur-splashed, lifeless floors under which there is the sound of bubbling and fermentation, with their foul, corrosive stench and weird noises. Seen from the human sphere of life, these hells lie beyond the primeval centers of earthly life, beyond the steaming island in the snowy wastes. Thus, between volcanic chaos and us, a symbol of original creation and a cradle of eternal life, lies the thermal spring.